1.0 Introduction

1.1 Purpose and Scope

The Department of Energy (DOE) Office of Oversight, within the Office of Environment, Safety and Health (EH), conducted an investigation of the Portsmouth Gaseous Diffusion Plant (PORTS or Plant) from January through May 2000. The purposes of this investigation were to (1) determine whether historical, environment, safety, and health (ES&H) activities and controls associated with uranium enrichment and supporting operations from initiation of Plant operations in 1954 until 1997 were in accordance with the knowledge, standards, and local requirements applicable at the time; (2) identify any additional ES&H concerns that have not been documented; and (3) determine whether current DOE and DOE contractor work practices since 1997 (when the Nuclear Regulatory Commission [NRC] assumed regulatory authority of the gaseous diffusion processes, facilities, and personnel) for DOE-controlled areas of PORTS adequately protect workers, the public, and the environment. This investigation was performed at the direction of the Secretary of Energy, who instructed EH to examine concerns about past operations and work practices, and current management of legacy materials at PORTS.

The activities at PORTS are being evaluated as a single, integrated investigation coordinated with other organizations that have regulatory authority at PORTS, including the State of Ohio, the NRC, the Environmental Protection Agency (EPA), and the Occupational Safety and Health Administration (OSHA). The scope of the investigation includes: (1) ES&H practices associated with operating (i.e., uranium enrichment) and support facilities from 1954 to March 3, 1997; (2) ES&H issues associated with these facilities and properties from 1997 to the present; and (3) facilities and properties under current DOE jurisdiction. Specific PORTS operations examined by the EH investigation team include: cascade operations; feed production; oxide conversion; landlord infrastructure activities; treatment, storage, and disposal of legacy and newly generated waste; site remediation; uranium hexafluoride (UF_6) cylinder storage; maintenance; facility decontamination and decommissioning; and polychlorinated biphenyl (PCB) collection, treatment, and cleanup. This investigation also examined the programs and activities of the organizations responsible for ensuring protection of the workers, the public, and the environment at PORTS, including the Oak Ridge Operations Office (OR), Portsmouth Site Office, Bechtel Jacobs, and key subcontractors, as well as the effectiveness of PORTS' implementation of its management and integration contract, including the complete transfer of agreed-upon ES&H functions to subcontractor organizations.

Specific areas excluded from this investigation include all current NRC-regulated activities at PORTS, and all United States Enrichment Corporation (USEC) activities specifically involving gaseous diffusion operations. Similarly, the results of other related evaluations being conducted by DOE—such as the mass balance, exposure assessment, and medical surveillance projects—are outside the scope of this investigation.

1.2 Current Operations and Hazardous Materials

PORTS is located near Piketon, Ohio, approximately 25 miles northeast of Portsmouth, Ohio, and two and a half miles east of the Scioto River. PORTS is approximately 3,714 acres, of which the gaseous diffusion plant occupies about 640 acres, of which 93 acres contain Plant process buildings. The current mission of the Plant is to "enrich" uranium for use in domestic and foreign commercial power reactors. In the past, the mission also included providing materials for weapons production and naval reactor fuel. Enrichment involves increasing the percentage of the uranium-235 isotope in the material used for creating reactor fuel (UF_6). Uranium-235 is highly

fissionable, unlike the more common isotope uranium-238. PORTS receives slightly enriched UF_6 from the Paducah Gaseous Diffusion Plant (which enriches 0.7 percent uranium-235 to about 1.95 percent uranium-235 currently) and further enriches the UF_6 up to 5 percent uranium-235. Figures 1, 2, and 3 are site maps and an aerial view of PORTS.

Over its operating lifetime, PORTS estimates that it has processed more than 336,000 metric tons of uranium. The uranium enrichment process involves moving UF_6 as a compressed gas through a series of diffusion stages; PORTS has over 4,000 diffusion stages. The diffusion process generates enriched uranium product and depleted uranium tails. The product is shipped to commercial customers for conversion to fuel rods and use in reactors. The tails, containing less than 0.5 percent uranium-235, remain at PORTS in cylinders and are shipped to Paducah for use as depleted feed.

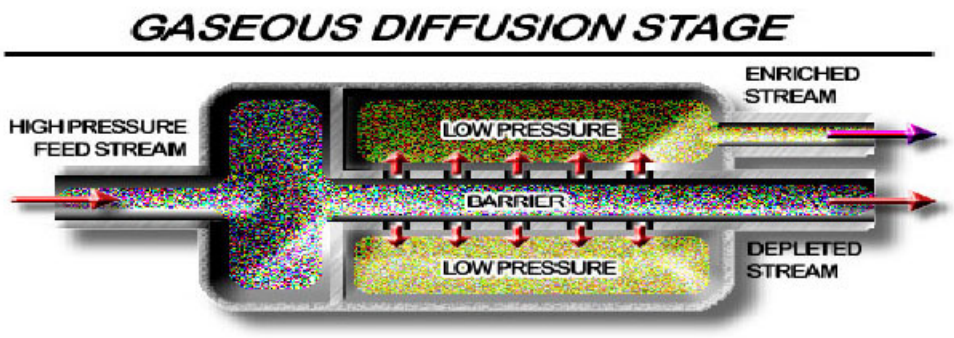
DOE is the site "landlord," owns the physical plant, and is responsible for some activities in X-326, the X-326 "L Cage" and its glovebox, the X-345 high assay sampling area, and the X-744G glovebox. DOE retains responsibility for legacy waste treatment, storage, and disposal; management of the depleted UF_6 cylinders; completion of the highly enriched uranium shutdown and removal program; and remediation of environmental contamination. In April 1998, DOE selected Bechtel Jacobs as the management and integrating contractor for PORTS. This contract mandates that Bechtel Jacobs subcontractors perform the majority of the work. Bechtel Jacobs recently awarded the last two major subcontracts to WASTREN to perform site services and waste management operations. Figure 4 provides organization charts for the DOE Portsmouth Site Office and Bechtel Jacobs.

USEC leased the enrichment production facilities on July 1, 1993, and contracted with Martin Marietta Utility Services, which became Lockheed Martin Utility Services, as the maintenance and operating contractor until May 1999, when USEC assumed responsibility for enrichment activities. The NRC performs regulatory oversight of USEC activities. OSHA regulates USEC occupational safety and worker health, and the State of Ohio and the EPA regulate USEC environmental activities. USEC is responsible for the process of separating uranium isotopes through gaseous diffusion and support operations. Support operations include feed and withdrawal of material from the primary process, potable and cooling water treatment, steam generation for heat, decontamination of equipment removed from the process for maintenance or replacement, recovery of uranium from various waste materials, and treatment of industrial wastes.

During the Plant's operating history, the process of enriching uranium for military and commercial applications has generated higher enriched product, tails, and radioactive and non-radioactive wastes. In addition, other radioactive and non-radioactive waste materials, not associated with naturally occurring uranium, have been introduced to the Plant and include transuranic elements (isotopes with atomic numbers greater than uranium) such as neptunium-237 and plutonium-239, fission products such as technetium-99, PCBs, and volatile organic compounds such as trichloroethene (TCE). These waste materials present differing levels of risk to workers and to the public depending upon their concentration, pathway of release, and method of exposure. Figure 5 shows the historical process of uranium enrichment and its byproducts.

1.3 Investigative Approach

The overall objectives of this investigation were to determine whether historical ES&H activities and controls were in accordance with the knowledge, standards, and local requirements applicable at the time; whether any additional ES&H concerns have not been documented; and whether current work and safety management practices for DOE-controlled areas of PORTS are sufficient to protect workers, the public, and the environment. Issues identified by the investigation team that are associated with the current implementation of ES&H programs are summarized in Volume 2.



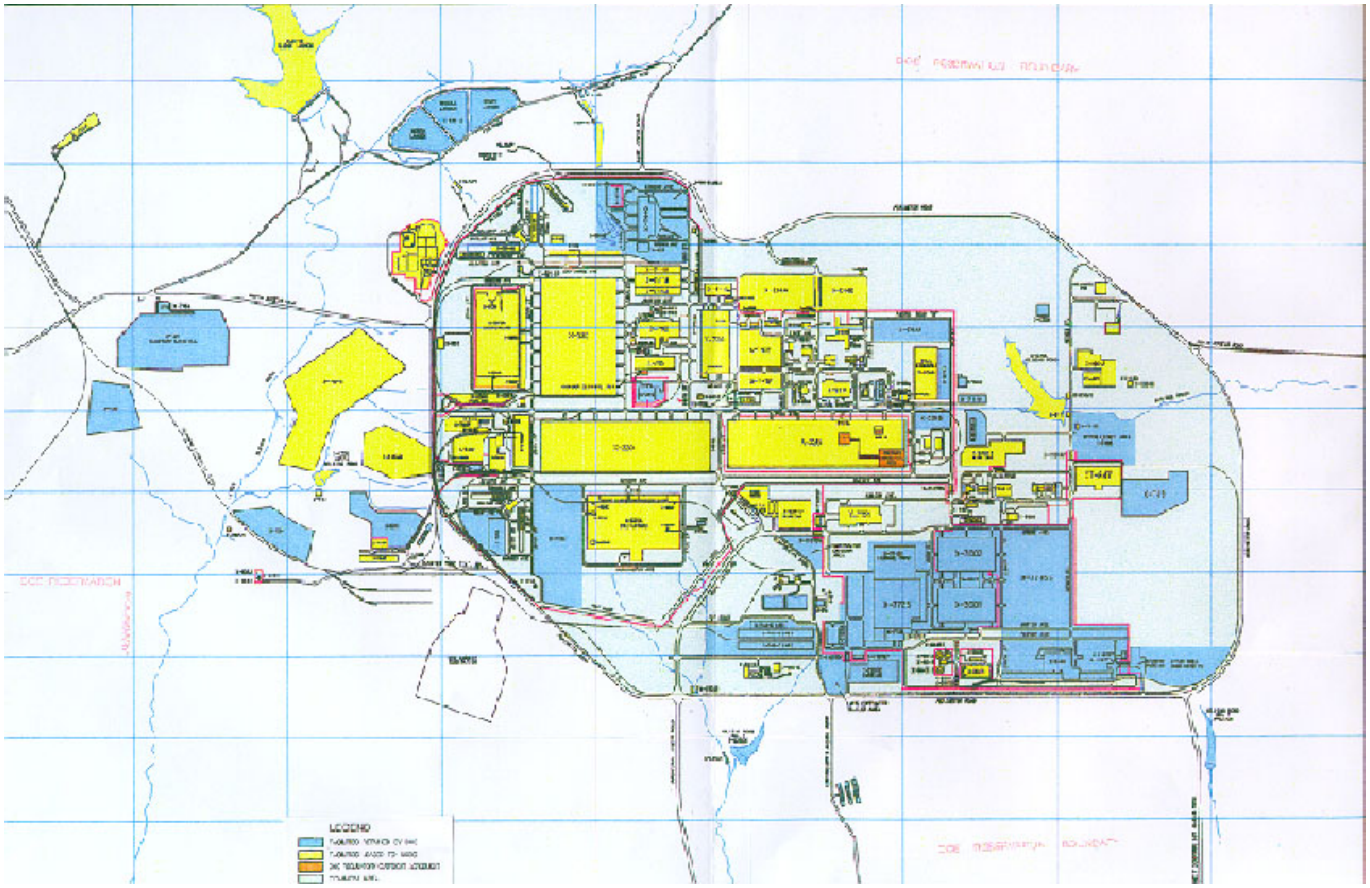


Figure 1. Map of Portsmouth Gaseous Diffusion Plant, Leased and DOE Controlled Areas

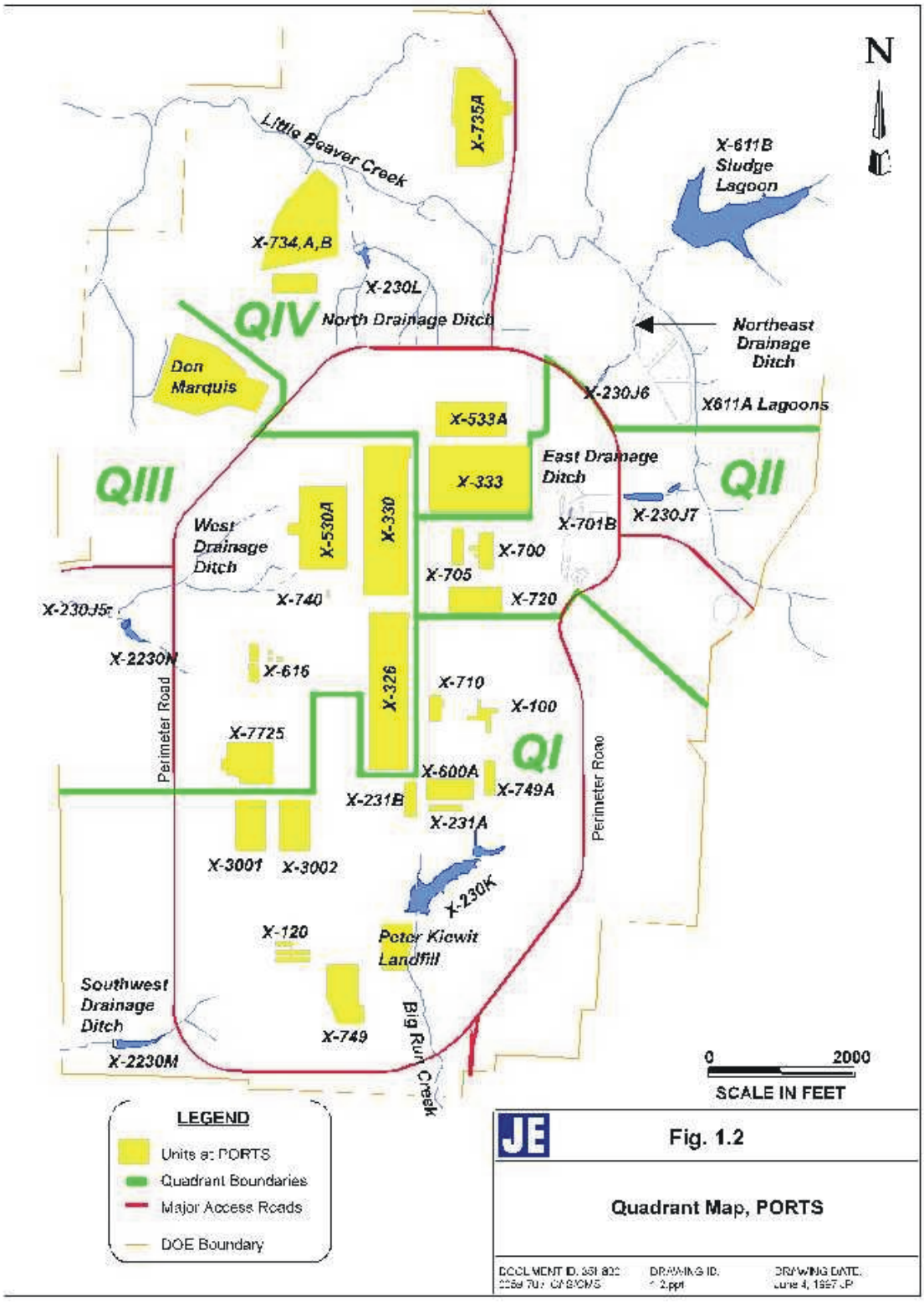


Figure 2. Map of Portsmouth Gaseous Diffusion Plant, Major Boundaries and Features

Figure 3. Aerial View of Portsmouth Gaseous Diffusion Plant

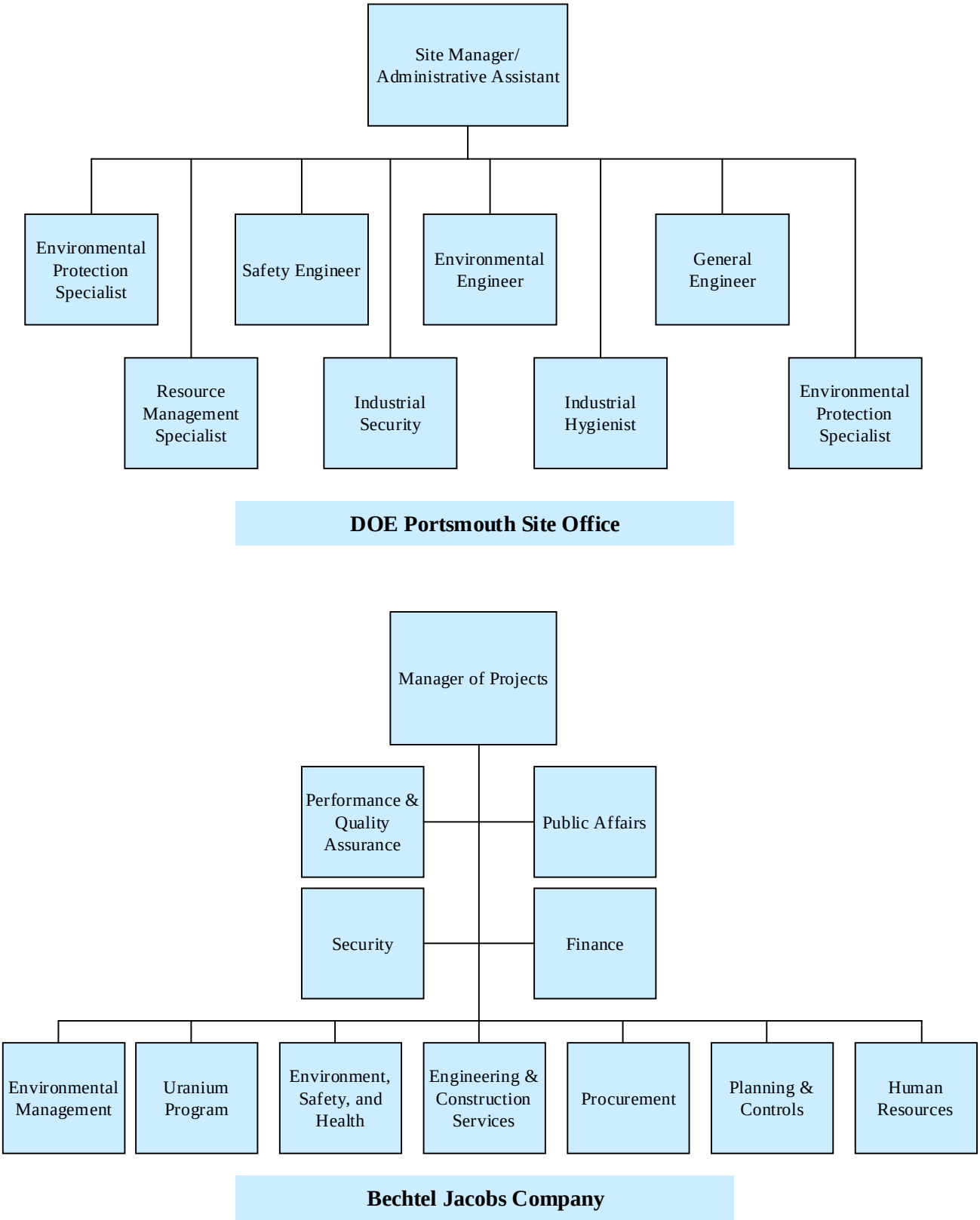


Figure 4. Organization Charts for the DOE Portsmouth Site Office and Bechtel Jacobs

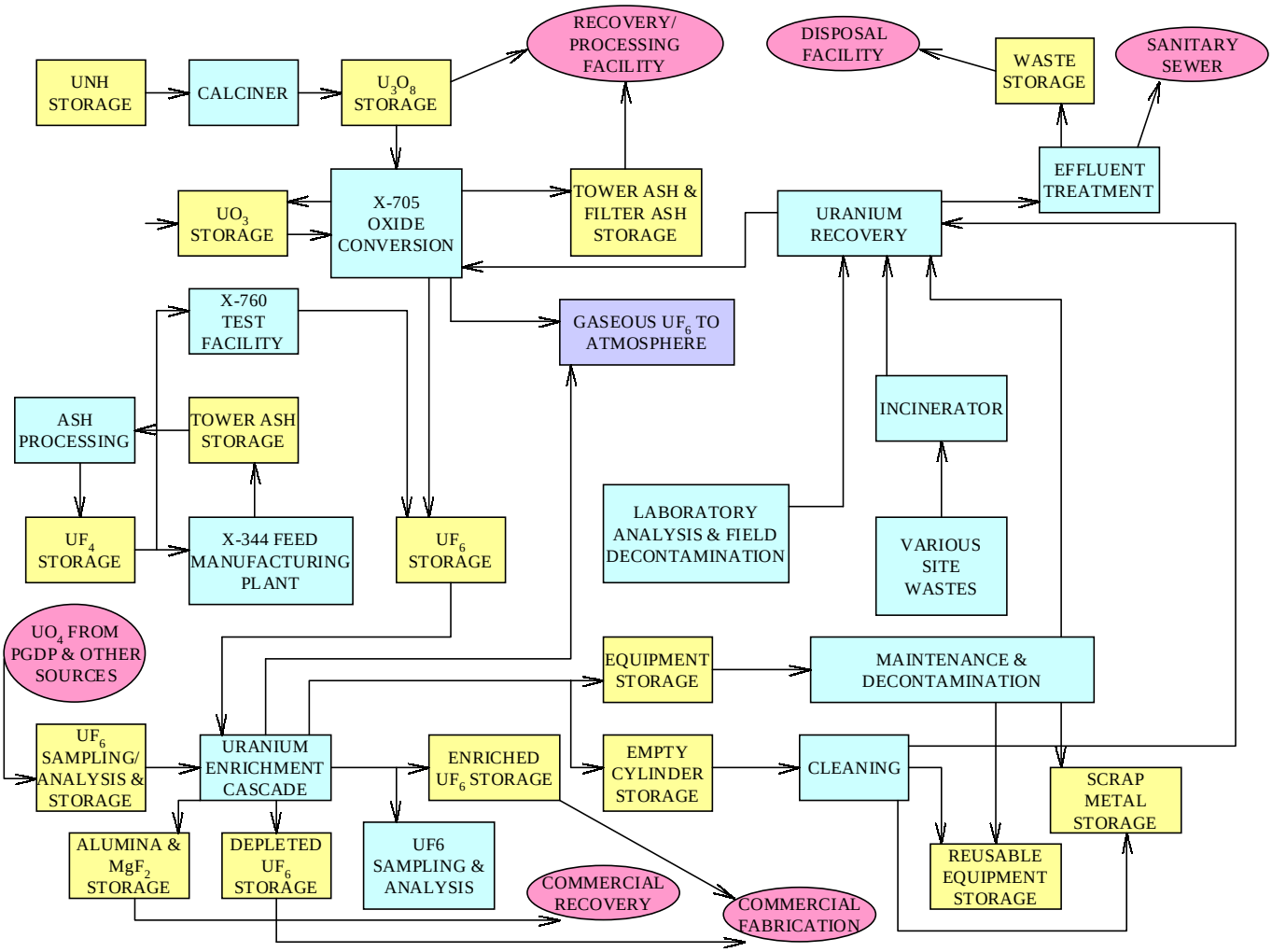


Figure 5. Schematic of Historical Uranium Enrichment Process

Interviews were conducted with over 300 current and former employees, including DOE Headquarters, OR, and Portsmouth Site Office personnel; Bechtel Jacobs and subcontractor managers, supervisors, and workers; selected USEC personnel; and stakeholders. USEC personnel were interviewed to clarify the nature of DOE activities conducted in USEC-controlled space and to better understand how USEC performs work for Bechtel Jacobs. Over 240 of these interviews resulted from a solicitation that the investigation team placed in local newspapers requesting information on past Plant operations, ES&H practices, and specific events that could have affected worker and public health and safety and environmental protection. These interviews also provided the investigation team with a preliminary indication of the degree to which ES&H practices and controls were consistent with and appropriate to the standards of the day, both past and present. This information allowed the investigation team to identify certain ES&H practices for more detailed document review.

The investigation team conducted numerous facility and work area walkthroughs examining Plant operations, work practices, and hazard controls. Essentially all DOE-controlled Plant facilities, waste and material storage areas, and grounds were visited by the investigation team. Many facilities and storage areas were examined multiple times. Job planning, maintenance, and operational activities were also observed to understand how work activities are planned and executed.

The investigation team collected 25 samples from groundwater wells, surface water sources, sediments, and soil (see Volume 2 of this report for more information). Samples were collected both inside and outside the perimeter security fence. These samples were evaluated for the presence of radioactive and non-radioactive contaminants. All samples were "split" or separated into two samples for running parallel tests, and samples were maintained under a strict chain of custody.

Boxes of Records Reviewed by the Investigation Team

To supplement the interview, observation, and sampling processes, the investigation team reviewed thousands of current and historical documents, including plans, procedures, log books, assessments, analyses, and reports and correspondence. These reviews supplemented the information from interviews and clarified the chronology of events at PORTS. The investigation team also examined documents addressing past standards to provide a framework for understanding ES&H requirements and expectations. Many records were obtained from PORTS archives documenting past releases of radioactive and hazardous materials and their potential impacts on workers, the public, and the environment.

This extensive process for gathering information enabled the team to proceed in a structured fashion to (1) understand past conditions; (2) fully comprehend the issues being raised regarding past operations, past work practices, and management of legacy materials; (3) evaluate the effectiveness of actions taken by PORTS to address ES&H issues; and (4) assess current conditions at PORTS and their impact on worker and public health and safety, and the protection of the environment.

1.4 Data Considerations

The scope of this investigation required that the investigation team examine current as well as legacy data and information. This involved both the review and evaluation of archived material and the assessment of recorded interviews documenting individuals' recollections of previous events and conditions. The investigation team recognized the inherent difficulty of current and former workers' accurately recalling details related to activities and events happening up to and perhaps more than 40 years ago. While the interview solicitation indicated the team's desire to speak with personnel who were involved in a variety of functions at the Plant, many individuals were self-selected for the interviews; that is, their participation resulted from their personal interest in the investigation. Accordingly, the team cross-checked information from multiple sources before making judgments contained in this report.

The identification and review of historical documentation was a tedious and time-consuming process. Due to the volume of records and other documentation generated over almost 50 years, the investigation team made a "best effort" to locate and review all pertinent documentation. Documents were examined based on focused subject searches and targeted sampling.

1.5 Report Structure

The results of this investigation are structured in two volumes to provide the reader with a comprehensive understanding of past and current activities at PORTS and a thorough description of operational, maintenance, and environmental management practices and their effectiveness in minimizing impacts on workers, the public, and the environment. Volume 1 describes historical ES&H practices. Volume 2 presents an assessment of current ES&H programs. To ensure that the full range of information is provided in an understandable manner, the balance of this volume is organized into a series of discussions outlining various elements of the Plant's operation in the context of when and how they were conducted.

Accordingly, Section 2 of this volume provides a historical overview and description of past activities at PORTS, within a series of functional areas that summarize key operations relating to the safety and health of workers, the public, and the environment. The objective of Section 2 is to provide an overall understanding of the major activities performed at PORTS and to indicate how these activities may have changed over time. More detailed discussions of historical operations and maintenance activities, environmental management, and line management and oversight practices are presented in the subsequent three sections.

Section 3 describes the hazards that historically existed at PORTS; past operational and maintenance activities; practices used to identify, monitor, and control these hazards; and the effectiveness of these practices in addressing hazards. Similarly, Section 4 describes past environmental management practices at PORTS and their effectiveness in mitigating impacts to the public and the environment. Finally, Section 5 reviews historical management and oversight practices as well as a discussion of employee relations.

Appendix A of Volume 1 outlines the radiological, chemical, and physical hazards present at the Plant.

Appendix B of Volume 1 summarizes the principal activities conducted at PORTS from 1952 to 1997 and provides a general assessment of the hazards presented by these activities, the controls used to mitigate the hazards, and the effectiveness of the controls.

Volume 2 of this report documents current conditions at PORTS in terms of public and environmental protection, worker health and safety, and line oversight. It examines existing pathways for hazardous materials to be transported to the environment and the extent of contamination in groundwater and in surface waters, efforts undertaken by PORTS to control contamination, results from the sampling and analysis conducted by the investigation team, the effectiveness of efforts to provide information to the public and other stakeholders, the nature and extent of risks that workers currently face at PORTS from both radiological and non-radiological hazards, the use of engineering and administrative controls to mitigate these hazards, the systems for planning and managing work, and the effectiveness of DOE and contractor management functions for ensuring protection of workers, the public, and the environment.

Appendix A of Volume 2 highlights significant issues in the implementation of current ES&H programs. The roster of the Office of Oversight investigation team is provided in Appendix B of Volume 2.